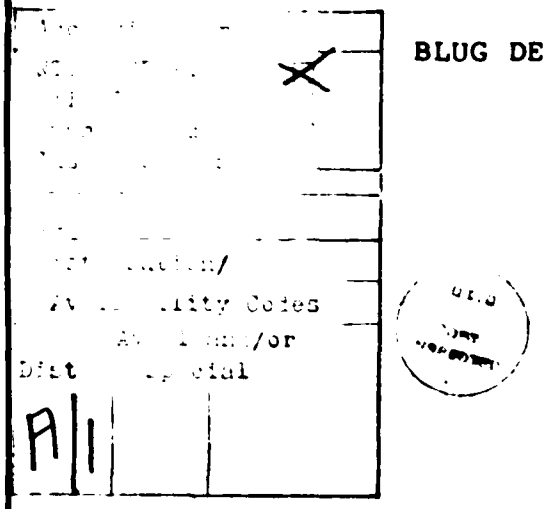
SCIENCE APPLICATIONS, INC.

BLUG DEVELOPMENT AND APPLICATIONS

SAI-84/1678

SCIENCE APPLICATIONS, INC.



BLUG DEVELOPMENT AND APPLICATIONS

SAI-84/1678

July 1984

Prepared for:

Mr. E. D. Chaika
Naval Ocean Research and Development Activity

Prepared by:

C. W. Spofford
R. R. Greene
W. F. Monet

FINAL REPORT ON

CONTRACT N00014-83-C-0235

SCIENCE APPLICATIONS, INC.

1710 Goodridge Drive
P.O. Box 1303
McLean, Virginia 22102
(702) 821-4300

Science Applications, Inc

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE	READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER: SAI-84/1678	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle): BLUG Development and Applications Final Report	5. TYPE OF REPORT & PERIOD COVERED: 2/22/83 - 7/21/84
	6. PERFORMING ORG. REPORT NUMBER: SAI-84/1678
7. AUTHOR(s): C. W. Spofford, R. R. Greene, W. F. Monet	8. CONTRACT OR GRANT NUMBER(s): N00014-83-C-0235
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Science Applications, Inc., 1710 Goodridge Drive, McLean, VA 22102	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS: Naval Ocean Research and Development Activity, NSTL Station, MS 39529 Code 270	12. REPORT DATE: July 1984
	13. NUMBER OF PAGES: 13
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)	15. SECURITY CLASS. (of this report): UNCLASSIFIED
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Unclassified, Unlimited

DISTRIBUTION STATEMENT A
Approved for public release;
Distribution Unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Bottom Loss, System Performance, Peak-power Processing, Transition, Shallow Water, Mediterranean

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report summarizes work performed by Science Applications, Inc. for the Naval Ocean Research and Development Activity on Contract N00014-83-C-0235 in technical areas relative to bottom loss. Three tasks, associated with SAI's work on the Bottom-Loss Upgrade (BLUG), are reported here:

(1) revisions, updates and extensions -- specifically development with NAVOCEANO and incorporation into BLUG of new →→ →

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE
S/N 0102-LF-014-6601

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

TABLE OF CONTENTS

ABSTRACT

This report summarizes work performed by Science Applications, Inc. for the Naval Ocean Research and Development Activity on Contract N00014-83-C-0235 in technical areas related to bottom loss. Three tasks, associated with SAI's work on the Bottom-Loss Upgrade (BLUG), are reported here:

(1) revisions, updates and extensions -- specifically development with NAVOCEANO and incorporation into BLUG of new geo-acoustic areas for the Mediterranean, and an extension into shallow water;

(2) mid-frequency transition -- improving BLUG predictions at mid to high frequencies;

(3) ASW System Performance impact -- development of graphic representations of the meaning of BLUG for system performance predictions.

Section 1
INTRODUCTION AND BACKGROUND

This contract required the extension of the Bottom Loss Upgrade (BLUG) and its application to Fleet ASW issues. Three tasks were performed as reported in the corresponding three sections. Much of the work has been reported in separate briefings and reports. This final report summarizes these activities in an unclassified forum.

Section 2
TASK 1 - BLUG REVISIONS, UPDATES AND EXTENSIONS

Introduction and Background

This task consists of two subtasks:

1) contractor shall revise, expand, and extend the Bottom Loss Upgrade to reflect new data and feedback from the testing/evaluation efforts. Extensions shall be as determined by the Scientific Officer but are expected to include selected high-priority shallow-water areas

2) continued support for BLUG will also encompass transition of configuration management and revision/expansion capability to the Naval Oceanographic Office. Contractor shall deliver the required software and data base modifications, together with technical documentation, and shall conduct training with NAVOCEANO personnel on BLUG methodology.

The Bottom Loss Upgrade (BLUG) is a data base, with associated extraction software, to be used for the prediction of the signal strength of ocean-bottom reflecting and refracting sound. It was developed by the Navy Systems Division of SAI, specifically to support the acoustic propagation prediction capability at the Fleet Numerical Oceanography Center (FNOC) in Monterey, CA. The BLUG data base was delivered to the Scientific Officer in FY82 for

installation at FNOC. As the developer of the data base, SAI was required to provide technical support to the two organizations which would assume operational responsibility for the data base. FNOC assumed responsibility for the testing and evaluation of the data base leading to an operational evaluation. The Naval Oceanographic Office (NOO) was designated to assume responsibility for the configuration management and revision/expansion of the data base. The BLUG data base as delivered to FNOC was designed in the context of acoustic propagation in the deep ocean. In addition to support tasks, SAI was also required by the Scientific Officer to extend the BLUG concept to shallow water. The Straits of Korea was selected by the sponsor as a test case.

Technical Approach

All work carried out in Task 1 was performed in a manner consistent with the technical documentation of the Bottom Loss Upgrade[1-5]. In each subtask involving a revision, expansion, or extension of the data base, every effort was made to ensure consistency with the established techniques. The technical documentation also served as the basis for the training that was conducted with NAVOCEANO personnel.

A simple and portable extraction algorithm for the digital version of the BLUG data base was supplied to NAVOCEANO. This simplified data base extraction system can be easily distributed to other users at the discretion of the Scientific Officer.

The geoacoustic area chart, developed for the Straits of Korea, is based upon surface sediment type. It is felt that propagation in shallow water of bottom-interacting

signals will depend most strongly on the sound-speed ratio at the water-sediment interface. The second most important consideration is the sediment thickness, followed by the combination of sediment attenuation and sound-speed gradient.

Work Performed

Three major changes to the data base that were implemented or supported by SAI included:

1) the support of NAVOCEANO in the expansion of the BLUG data base to the South Atlantic

2) the generation of an extension of the BLUG concepts in the form of a detailed map of geo-acoustic areas for the Straits of Korea, a strategic shallow water choke point, and

3) work in conjunction with NAVOCEANO to complete a major revision of the BLUG data base in the Mediterranean Sea.

The Mediterranean BLUG revision served as a training exercise for the NAVOCEANO personnel in BLUG data base development. SAI supported NAVOCEANO through each step of the development process:

1) bottom-loss data interpretation

2) preliminary geological assessment of measurement sites

3) inversion of the bottom-loss data to determine geo-acoustic parameters

4) geo-acoustic area definition, and

5) extrapolation of geo-acoustic parameters from measurement sites to geo-acoustic areas.

All documentation[1-5] of the BLUG data base generated by SAI was distributed to NAVOCEANO. A digital form of the data base with simplified extraction routines, and colo- . charts for the four ocean basins derived from the data ses were also provided to NAVOCEANO. The bottom-loss dat; nversion software for the derivation of geo-acoustic para.e .rs was installed at NAVOCEANO on a previous contract.

Section 3
TASK 2 - MID-FREQUENCY TRANSITION

The objective of this task was to improve the BLUG predictions at mid to high frequencies. Presently BLUG uses an artificial surface layer of anomalous impedence to produce observed behavior in bottom-loss data. Progress on this task was dependent on work in the Bottom Interaction Program where the physically real near-surface sediment layering was shown to produce the very low, observed losses.

While this work showed considerable promise, the original suggested approach for BLUG improvements, involving the extrapolation of thin layer effects from core samples, seemed premature since the dominant factors had not yet been clearly identified.

An alternative approach has been pursued which may be more practical. In the course of investigating this approach, a troublesome inconsistency between NAVOCEANO MGS curves and BLUG predictions at comparable frequencies has been resolved. Its resolution also has a significant impact on active sonar predictions and an understanding of a major problem in bottom-bounce ASW.

The alternative approach would use the geographically assigned high-frequency MGS class (1-9) to indicate areas where high-angle, high-frequency losses were anomalously less than the low-frequency losses at similar angles. This high-frequency loss can be used directly to infer the required impedence of the artificial thin layer. Hence the MGS areas could be used to deduce the presence and magnitude of the anomalous layer.

When this approach was first tried, an unexpected difficulty was encountered. Spot checks of NADC high-frequency data and MGS areas showed a large number of discrepancies where agreement had been expected. Usually BLUG (and the NADC data upon which BLUG is based) showed less loss than the MGS curves, sometimes by more than 10 dB. This problem was also encountered by the APP Bottom-Loss Evaluation (ABLE) Committee in its deliberations concerning high-frequency curves. For the remainder of the effort SAI worked with various ABLE members to resolve this apparent inconsistency.

The crux of the problem lies in the fact that the MGS high-frequency curves were based on sonar-simulator results in which the peak energy in a 10-msec, 100-Hz bandwidth signal was used to compute bottom loss. NADC (and later NOO) were computing the total energy over the duration of the received bottom return (frequently much longer than 10 msec). The problem then revolved around differences between "peak" and "total" energy.

Because the MGS curves represent only "peak" energy in a 10-msec window, some way is needed to relate them to total energy and BLUG. Work by Bell and Jensen at NUSC has led to approximate energy correction factors by MGS class for the higher angles. Work is still required to develop these for lower angles as well. Working with NUSC, we were able to resolve the differences between the timespreads inferred from the NUSC energy corrections, and the much larger timespreads observed in some of the NOO data.

The resolution of this difference is to be reported in detail elsewhere, however the fundamental issue concerns

statistics of the TB=1 sample that the 10-msec 100-Hz peak value represents.

As a result of this effort, it appears that with some additional work at NUSC, total energy equivalents to the MGS curves will be obtainable. From these, geographic extrapolation of the anomalous thin-layer effect in BLUG should be possible.

Section 4
TASK 3 - BLUG-ASW SYSTEM PERFORMANCE IMPACT

This task required the development of computer-generated graphical depictions of components of the BLUG data base and processed BLUG data intended to alert the Fleet user as to the ASW significance of the BLUG areas. The difficulty with BLUG was that in going from a few curves to a set of nine geo-acoustic parameters from which curves can be derived, the Fleet user has difficulty deciding where a bottom is "good" or "poor" or whether it will change for better or worse in changing location. The answer to these questions is a function of both frequency and grazing angle (unlike the previous curves which were uniformly good or poor independent of angle or frequency).

After several meetings with NORDA, NOO, CNOC, and FNOC personnel, candidate prescriptions were agreed upon to illustrate this effect. (An additional prescription was developed for APP purposes.) A draft report was prepared for dissemination to the Fleet support centers for comment containing sample charts for the NW Atlantic. Once comments on content and format are received, ocean-wide charts will be developed. The samples are contained in the following reference:

> Guidance on Fleet Impact of the Bottom Loss Upgrade, SAI-83/1313, December 1983, C. W. Spofford, Science Applications, Inc.

Section 5

REFERENCES

1. C. W. Spofford, "BLUG Overview", SAI report: SAI-84-142-WA (1983).

2. C. W. Spofford, R. R. Greene, and J. B. Hersey, "The Estimation of Geo-acoustic Ocean Sediment Parameters from Measured Bottom-loss Data", SAI report: SAI-83-879-WA (1983).

3. W. F. Monet, R. R. Greene, and C. W. Spofford, "Development of Geo-acoustic Areas for the Bottom-Loss Upgrade", SAI report: SAI-83-976-WA (1983).

4. R. R. Greene and C. W. Spofford, "Comparisons of NADC Measured Bottom Loss with BLUG Simulated Bottom Loss", SAI report: SAI-84-138-WA (1983).

5. C. W. Spofford, W. W. Renner, and H. J. Venne, "Modifications to FACT and ASTRAL for the Bottom-Loss Upgrade", SAI report: SAI-84-148-WA (1983).